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FOR

DIFFERENTIAL BASIS WEIGHT NONWOVEN WEBS

OF

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DIFFERENTIAL BASIS WEIGHT NONWOVEN WEBS

Field of the Invention

The present invention is generally directed to nonwoven webs, laminates containing nonwoven webs and to a process for forming the webs. More particularly, the present invention is directed to meltspun webs having areas of lower basis weight and areas of higher basis weight.

Background of the Invention

Polymeric and cellulosic articles, such as fibers and webs, are useful for a wide variety of applications. For instance, thermoplastic polymeric fibers, pulp fibers, and webs have been used in the past for making fluid absorbent wipers, towels, industrial garments, medical garments, medical drapes, and the like. Such articles are also used in recreational applications, such as for making tents and car covers. Nonwoven fabrics made from polymeric fibers have also achieved especially widespread use in the manufacture of personal care articles, such as diapers, feminine hygiene products and the like.

The nonwoven fabrics identified above particularly refer to webs made via the spunbond, meltblown, coform, or carded web processes. For instance, spunbond webs are typically produced by heating a thermoplastic polymeric resin to at least its softening temperature. The polymeric resin is then extruded through a spinnerette to form continuous fibers, which can then be subsequently fed through a fiber draw unit. From the fiber draw unit, the fibers are spread onto a foraminous surface where they are formed into a web. In particular, a vacuum is created below the foraminous surface forming a suction force which draws the fibers onto the foraminous surface. The formed web is then bonded such as by chemical,

thermal, or ultrasonic means.

Meltblown fabrics, on the other hand, have been conventionally made by extruding a thermoplastic polymeric material through a die to form fibers. As the molten polymer filaments exit the die, a high pressure fluid, such as heated air or steam, attenuates the molten polymer filaments to form fine fibers. Surrounding cool air is induced into the hot air stream which cools and solidifies the fibers. The fibers are then randomly deposited onto a foraminous surface to form a web. The web has integrity as made but may be additionally bonded.

Bonded carded webs refer to webs produced by carding a batt of fibers. Once the batt of fibers is carded into a web, the web can be folded over and needle punched in order to increase the thickness of the web. When using fibers made from synthetic polymers, in order to increase the strength and integrity of the web, the fibers can be meltbonded together. For instance, the carded web can be brought into contact with a heated roller which is at a temperature sufficient to soften the synthetic polymer.

Coform webs generally refer to polymeric nonwoven webs that contain a filler. The filler incorporated into the web can be, for instance, absorbent particles, pulp fibers, or other solid materials.

For most applications, nonwoven webs typically must exhibit a combination of physical properties that make the webs well suited for their intended function. For instance, for most applications, nonwoven webs should have adequate softness, strength and absorbency characteristics. For example, liners used in diapers, feminine hygiene products, and other liquid absorbable products

should be relatively strong, but should also be highly liquid permeable for allowing liquids contacting the surface of the liner to be absorbed into the interior of the product.

Unfortunately, when one property of a nonwoven web is improved, typically other properties of the web are adversely affected. For instance, when the liquid permeability of nonwoven webs is increased, often the strength of the web is decreased.

Currently, various needs remain in methods for controlling the properties of nonwoven webs. A need further exists for nonwoven webs that exhibit an improved combination of properties, such as strength and liquid permeability characteristics.

Summary of the Invention

The present invention is directed to further improvements in producing nonwoven webs having desired properties.

Accordingly, an object of the present invention is to provide a process by which the physical properties of a nonwoven web made from polymeric fibers can be controlled.

Another object of the present invention is to provide novel nonwoven webs that exhibit a desirable combination of properties.

Still another object of the present invention is to provide nonwoven webs having a controlled varying basis weight made from polymeric fibers or pulp fibers.

It is another object of the present invention to provide nonwoven webs that have first areas and second areas that form a predetermined pattern and wherein the basis weight of the web within the first areas is greater than the basis weight within the second areas.

Still another object of the present invention is to provide laminates that contain a nonwoven web

which has a varying basis weight.

These and other objects of the present invention are achieved by providing a nonwoven web made from polymeric fibers, such as fibers made from a spunbond or meltblown process. The nonwoven web defines first areas having a first basis weight and second areas having a second basis weight. In particular, the first areas have a basis weight from about 1.5 to about 5 times greater than the basis weight of the second areas and particularly from about 1.5 to 3 times greater than the basis weight of the second areas. In general, the average basis weight of the web can vary from about 0.2 ounces per square yard to about 9 ounces per square yard and particularly from about 0.3 ounces per square yard to about 4 ounces per square yard.

The first and second areas contained within the web can be formed according to a random pattern or according to a pattern on the forming wire which locally controls the air flow velocity. For instance, the first and second areas can form alternating columns, alternating columns and rows, or can form a checkered pattern within the web. The checkered pattern can be formed by the heavy area forming the grid or the light area forming the grid. For most applications, the first areas should comprise from about 25% to about 75% of the nonwoven web, and particularly from about 40% to about 60% of the nonwoven web.

The polymeric fibers used to produce the nonwoven web can be made from various materials including elastomeric polymers, polypropylene, polyethylene, polyester, and nylon. The fibers can be monocomponent fibers or multicomponent fibers, such as bicomponent fibers. The fibers can also be continuous filaments or discontinuous fibers. In

applications where high loft is desired, crimped fibers can be used.

Besides the above-described nonwoven webs, the present invention is also directed to laminates incorporating the webs. For instance, in one embodiment, a laminate product can be produced in which a spunbond web as described above is laminated with a meltblown web. In a further alternative embodiment, a meltblown web can be placed in between two outer layers of spunbond webs, in which at least one of the spunbond webs has a varying basis weight. In still another embodiment, the laminate can contain a film besides other nonwoven webs.

The nonwoven webs of the present invention having areas of higher basis weight and areas of lower basis weight are generally produced by extruding a thermoplastic polymer through a die to form fibers. The fibers are directed onto a foraminous surface by an airflow which is created by a vacuum under the foraminous surface. According to the present invention, the foraminous surface has a predetermined pattern of lower and higher permeability sections or regions.

A nonwoven web is formed on the foraminous surface from the fibers. The formed web defines first areas having a first basis weight and second areas having a second basis weight that is lower than the first basis weight. Specifically, the second areas are formed on the foraminous surface where the lower permeability sections are located.

In a spunbond process, after being extruded, the fibers are drawn through a fiber draw unit. From the fiber draw unit, the fibers are directed onto the foraminous surface. The distance between the fiber draw unit and the foraminous surface can be, for instance, from about 9 inches to about 20

inches.

Other objects, features and aspects of the present invention are discussed in greater detail below.

Brief Description of the Drawings

A full and enabling disclosure of the present invention, including the best mode thereof to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures in which:

Figure 1 is a schematic drawing of a spunbond process for producing nonwoven webs;

Figure 2 is a plan view of one embodiment of a nonwoven web made in accordance with the present invention;

Figure 2A is a side view of the embodiment illustrated in Figure 2;

Figure 3 is an alternative embodiment of a nonwoven web made in accordance with the present invention;

Figure 4 is a further alternative embodiment of a nonwoven web made in accordance with the present invention; and

Figure 5 is a further alternative embodiment of a nonwoven web made in accordance with the present invention.

Repeat use of reference characters in the present specification and drawings is intended to represent same or analogous features or elements of the invention.

Detailed Description of Preferred Embodiments

It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present invention, which broader aspects are

embodied in the exemplary construction.

The present invention is directed to nonwoven webs, such as spunbond webs, meltblown webs, coform webs, air laid webs or bonded carded webs having higher basis weight areas and lower basis weight areas. As used herein, the basis weight of a web refers to the mass of material per unit area. For example, basis weight can be measured according to ASTM test number D3776-96 Option C and can be measured in ounces per square yard. The differential basis weights can be contained within the nonwoven web according to a random pattern or according to a predefined pattern.

The ability to produce nonwoven webs having a differential basis weight offers several benefits and advantages. For instance, the basis weight differential can provide mechanical strength or stability in the direction of the higher basis weight areas and low stability or strength in the lower basis weight areas. Thus, a given pattern can be used to adjust and control the strength and stability of the web in the machine direction or the cross direction. Likewise, the higher and lower basis weights provide areas of low and high liquid and/or gas and/or vapor permeability which can be useful for fluid handling and control. These advantages are present in either high loft webs or low loft webs.

Nonwoven webs made according to the present invention can be used in many diverse and different applications. For instance, the nonwoven webs are particularly well suited for use in laminates that are used to make such products as garments, especially breathable garments, wipers, diapers, feminine hygiene products, and the like. The nonwoven webs can also be used as filters, especially when zone filtering is required or

beneficial. It has also been discovered that by stretching a nonwoven web made in accordance with the present invention, the web has been shown to have potential as a loop material in hook and loop fasteners, such as VELCRO fasteners.

In one embodiment of the present invention, the nonwoven web is used either as a surge material, a liner material, or as an outer cover in a diaper or other similar product. Webs made according to the present invention are particularly well suited for these applications due to their fluid handling and control characteristics along with their strength characteristics. In particular, the light basis weight portions of the web will pass fluids to an absorbent material, while the higher basis weight areas provide the necessary strength for such applications. In fact, it has been discovered that the lower basis weight areas create channels within the web into which liquids are directed, providing the web with great liquid permeability, low run-off properties and fluid distribution properties.

In the past, in order to produce webs with high liquid permeability and adequate strength, typically the webs had to be treated with a surfactant in order to increase the wettability of the web while maintaining strength. High strength webs having low run-off properties, however, can be produced according to the present invention without the need of surfactants.

One process for producing nonwoven webs having a varying basis weight according to the present invention will now be discussed in detail with reference to Figure 1. In particular, Figure 1 illustrates a spunbond process. It should be understood, however, that other processes may be used in producing the webs of the present

invention. For instance, in an alternative embodiment, the webs may be produced according to a meltblown process, an air laid process, a coform process, or a bonded carded process. More generally, any process can be used which controls the formation of a material made from filaments and/or fibers by the application of an airflow such as is generated by a vacuum.

Turning to Figure 1, a process line 10 for preparing a nonwoven web according to the present invention is disclosed. The process line 10 is arranged to produce continuous monofilaments, but it should be understood that the present invention comprehends nonwoven fabrics made from other types of fibers including multicomponent filaments having two or more components, discontinuous filaments, or even pulp fibers.

Process line 10 includes an extruder 12 for extruding a polymeric material. The polymeric material is fed into the extruder from a hopper 14. From extruder 12, the polymeric material is fed through a polymer conduit 16 to a spinnerette 18.

Spinnerettes for extruding filaments are well-known to those of ordinary skill in the art and thus are not described here in detail. Generally described, the spinnerette 18 includes a housing containing a spin pack which includes a plurality of plates stacked one on top of the other with a pattern of openings arranged to create flow paths for directing the polymeric material through the spinnerette. The spinnerette 18 has round or shaped capillaries arranged in one or more rows and/or in one or more columns. The spinnerette openings form a downwardly extending curtain of filaments when the polymer is extruded through the spinnerette.

The polymeric material used to form the

filaments can be any suitable thermoplastic polymer. For instance, the polymeric material can be a polyolefin, polyester, nylon, or mixtures thereof. The polymeric material could also be elastomeric polymers such as polyurethanes, polyether amides, polyether esters, elastomeric polyolefins, etc. In one preferred embodiment, the filaments are made from polypropylene.

A fiber draw unit or aspirator 22 is positioned below the spinnerette 18 and receives the filaments. Fiber draw units or aspirators for use in melt spinning polymers are well-known as discussed above. Suitable fiber draw units for use in the process of the present invention include a linear fiber aspirator of the type shown in U.S. Pat. No. 3,802,817 and eductive guns of the type shown in U.S. Patent Nos. 3,692,618 and 3,423,266, the disclosures of which are incorporated herein by reference.

Generally described, the fiber draw unit 22 includes an elongate vertical passage through which the filaments are drawn by aspirating air entering from the sides of the passage and flowing downwardly through the passage. A blower or compressor with or without a heater 24 supplies aspirating air to the fiber draw unit 22. The aspirating air draws the filaments and ambient air through the fiber draw unit.

An endless foraminous forming surface 26 is positioned below the fiber draw unit 22 and receives the continuous filaments from the outlet opening of the fiber draw unit. The forming surface 26 travels around guide rollers 28. A vacuum 30 positioned below the forming surface 26 where the filaments are deposited draws the filaments against the forming surface.

As shown in Figure 1, forming surface 26

comprises an endless wire that travels around guide roller 28. In an alternative embodiment, however, a drum forming unit can be placed below fiber draw unit 22 and can contain a forming surface for receiving the filaments.

The process line 10 further includes a bonding apparatus such as thermal point bonding rollers 34 (shown in phantom) or a through-air bonder 36. Thermal point bonders and through-air bonders are well-known to those skilled in the art and are not disclosed here in detail. Lastly, the process line 10 includes a winding roll 42 for taking up the finished fabric.

In one alternative embodiment of the present invention, when it is desirable to crimp the filaments as they are formed, process line 10 can include a quench blower 20 positioned adjacent to the curtain of filaments extending from the spinnerette 18. Air from the quench air blower 20 quenches the filaments. Heater or blower 24 can then be used to activate the latent crimp of the filaments causing the filaments to naturally crimp.

Using crimped fibers in forming the nonwoven webs of the present invention offers various advantages depending upon the particular application. In general, using crimped fibers increases the loft of the resulting web. Increasing the loft can increase the ability of the web to absorb and/or transfer fluids. High loft webs are also typically desired when the nonwoven web is used as a loop material in a hook and loop fastener. When used as filter media, high loft webs provide improved filtration properties while maintaining lower pressure drops.

In general, to operate the process line 10, hopper 14 is filled with a polymeric material. The polymeric material is melted and extruded by the

extruder 12 and then directed into polymer conduit 16 and the spinnerette 18. The temperature at which the polymer is extruded depends on the particular polymer used. When polypropylene or polyethylene is used, the preferred temperature of the polymer when extruded ranges from about 370°F to about 530°F and preferably from about 400°F to about 450°F.

From spinneret 18, the filaments are drawn into the vertical passage of the fiber draw unit 22 by a flow of a gas, such as air, from the blower or compressor with or without a heater 24 through the fiber draw unit. The fiber draw unit is preferably positioned 30 to 60 inches below the bottom of the spinneret 18.

The filaments are then deposited through the outlet opening of the fiber draw unit 22 onto the traveling forming surface 26. The vacuum 30 draws the filaments against the forming surface 26 to form an unbonded, nonwoven web of continuous filaments. If necessary, the web is then lightly compressed by a compression roller 32 and then thermal point bonded by rollers 34 or through-air bonded in the through-air bonder 36.

Besides using through-air bonders or thermal point bonders, the web can also be bonded according to other methods. For instance, the web can be bonded through hydroentanglement or through needle punching. It should be understood, however, that non-bonded webs can also be made in accordance with the present invention.

Lastly, the finished web is wound onto the winding roller 42 and is ready for further treatment or use.

In accordance with the present invention, in order to form a nonwoven web having regions of higher and lower basis weight in a distinct

pattern, in one embodiment, the forming surface 26 can include a corresponding pattern of higher air permeability areas and lower permeability areas. In other words, suction air being generated by vacuum 30 is blocked off or restricted according to a particular pattern in forming surface 26 which is under the landing zone of the filaments exiting fiber draw unit 22. In this manner, a greater density of filaments is drawn to the areas of higher air permeability in the forming surface 26 while a lesser density of filaments is drawn to the areas of lower permeability. By blocking off portions of the forming surface, higher air velocity and lower air velocity areas through the forming surface 26 are created.

The manner in which the forming surface is blocked off can vary depending upon the desired result. For instance, a coating, such as glue or caulk, can be placed on the forming surface where the non-permeable areas are desired. Alternatively, the forming surface can be fabricated with a varying screen mesh for creating the different permeabilities. According to the present invention, the lower permeability areas can be created by completely blocking off the forming surface from vacuum 30 or by creating a permeability differential on or in the forming surface.

When using a nonbonded web in the process as described above, some precautions may need to be taken in order to prevent the web from losing all of its integrity. For instance, in one embodiment, a perforated plate can be placed over the web. High pressure air can then be blown through the perforations. The filaments under the perforations would then be hit by the high velocity air and forced to move away from the air jets, which would

create lower basis weight areas similar to the above described process.

The amount of difference in basis weight that is formed in the web will depend on various factors. For instance, the extent to which the basis weight in the web differs will depend upon how the forming surface is blocked off and the amount of suction force created by vacuum 30. Also, the basis weight differential in the web can be increased or decreased by increasing or decreasing the distance the filaments travel between fiber draw unit 22 and forming surface 26. For example, increasing the distance between the fiber draw unit and the forming surface will create greater differences in basis weight. This is because the filaments are moving at a slower velocity the further they are from the exit of the fiber draw unit, and the forming wire air can have a greater effect on the location that the filaments impact the forming wire. For most applications, fiber draw unit 22 can be from about 9 inches to about 20 inches from forming surface 26.

The manner in which the basis weight of a web made in accordance with the present invention will vary, in this embodiment, will generally depend upon the manner in which the permeability of the forming surface is varied. For instance, in one extreme, the forming surface can have fully open permeability areas and fully closed permeability areas creating the greatest amount of differential in basis weight. Alternatively, the forming surface can have a permeability profile in which the permeability of the forming surface gradually decreases from higher permeability to lower permeability areas. In this embodiment, the basis weight of a web formed on the surface will gradually decrease from the higher basis weight

areas to the lower basis weight areas in a predetermined, controlled manner as desired. The manner in which the basis weight is varied within a web will generally depend upon the particular application.

Besides blocking off the forming air in a melt spinning process, a basis weight differential can be formed in nonwoven webs in other manners. For instance, in an alternative embodiment, a regularly formed web can be perforated to create the lower basis weight areas on the web. In particular, a relatively heavier weight spunbond web could be perforated according to a particular pattern and then a light layer of extruded filaments, such as spunbond filaments, can be formed on top of the perforated web in order to provide the web with continuity and strength.

Differential basis weight nonwoven webs made according to the present invention can be made having an almost limitless variety of different patterns with respect to where the higher basis weight areas and the lower basis weight areas are located. For instance, the higher basis weight areas and lower basis weight areas can be formed into a predetermined random pattern or can be formed into a geometrical pattern. In particular, the higher basis weight areas and lower basis weight areas can form alternating columns, alternating rows and columns, or can form a checkered or dotted pattern.

Referring to Figure 2 and Figure 2A, one embodiment of a nonwoven web generally 50 made in accordance with the present invention is illustrated. In this embodiment, nonwoven web 50 includes lower basis weight areas 52 and higher basis weight areas 54. As shown, lower basis weight areas 52 and higher basis weight areas 54

form alternating columns. Depending upon the particular application, the columns can be formed in the machine direction or can be formed perpendicular to the machine direction i.e., in the cross-machine direction of the web. In general, if the columns are in the machine direction, the web strength in the cross-machine direction will be low and vice versa.

The columnar pattern illustrated in Figure 2 has been found to be particularly well suited for use as a liner or surge material in diapers and other liquid absorbent products. In these applications, the width of the columns can range from about ⅛ of an inch to about 1 inch. The width of the higher basis weight columns and the lower basis weight columns can be the same or can vary within the above range.

Referring to Figure 3, an alternative embodiment of a nonwoven web generally 60 made in accordance with the present invention is illustrated. In this embodiment, higher basis weight areas 64 form columns and rows in the web. Lower basis weight areas 62, on the other hand, appear as squares separating the columns and rows. This design maintains the web strength in the machine direction and the cross-machine direction.

If desired, in one embodiment, nonwoven web 60 can include highest basis weight areas 66 located where the rows and columns intersect. Highest basis weight areas 66 can have a basis weight that is higher than areas 64. In this manner, web 60 includes three distinct basis weight areas forming a basis weight differential particularly well suited for use in filter and liquid absorbent applications.

A further alternative embodiment of a nonwoven web generally 70 made in accordance with the

present invention is illustrated in Figure 4. As shown in this embodiment, a checkered pattern is formed by lower basis weight areas 72 and higher basis weight areas 74.

Still another alternative embodiment of a nonwoven web generally 80 made in accordance with the present invention is illustrated in Figure 5. As shown in this embodiment, the web includes lower basis weight areas 84, which appear in the form of small discreet shapes, such as dots, that are arranged according to a geometric pattern. Alternatively, however, dots 84 could be arranged randomly. The web surrounding the dots comprises a higher basis weight area 82.

In this embodiment, the small discreet shapes of lower basis weight can be formed into the web in order to provide high permeability areas for the passage of gases, vapors, or liquids. By appearing in small discreet shapes, the strength of the web is not unduly compromised.

It should be understood, however, that besides the various embodiments illustrated many different other patterns can be formed into the web depending upon the particular application. Further, webs can be formed in accordance with the present invention that include more than one pattern formed into the same sheet.

Further, besides the above described patterns, logos, designs, and water marks can also be formed into the web according to the present invention. For instance, the forming surface could be blocked off with a word, phrase, or logo, which would cause the word, phrase, or logo to appear in the material as a lower basis weight area.

In still a further embodiment, a web made according to the present invention can include a single lower basis weight area that is positioned

in a particular location on the web where higher permeabilities are desired. For instance, in one embodiment, the web of the present invention can be used as a diaper liner. In general, a diaper liner is the material that is placed adjacent to the wearer's body. Preferably, a diaper liner is liquid permeable so that liquids are drawn away from the person wearing the diaper and absorbed into the interior of the diaper. According to the present invention, a diaper liner can be constructed that includes a lower basis weight, higher permeability area in the "target area" of the diaper where the diaper is most likely to be contacted with liquids.

For example, for most applications, the target area would be the crotch area of the diaper. In this manner, a diaper liner can be constructed that includes a lower basis weight, higher liquid permeable area as desired while also having higher basis weight areas for providing strength to the garment. The heavy basis weight areas also prevent liquid flow back to the skin. As described above, in this embodiment, the basis weight of the diaper liner can go directly from high to low in the target area or can gradually vary from the higher basis weight areas to the lower basis weight area so that the lowest basis weight contained in the web is located directly in the center of the target area. In this manner, the diaper liner can contain a lower basis weight area while possibly maximizing strength. This lower basis weight target area could be, for instance, 2 inches wide and 4 inches long.

Alternatively, a web made according to the present invention can include a single higher basis weight area that is positioned in a particular location on the web where lower permeabilities are

desired. The higher basis weight area can be surrounded by a lower basis weight web.

The ratio of higher basis weight areas to lower basis weight areas can also be varied as desired. For most applications, however, the higher basis weight areas should comprise from about 25% to about 75% of the total surface area of the web. More particularly, the higher basis weight areas can comprise from about 40% to about 60% of the web. In one preferred embodiment, 50% of the surface area of the web comprises higher basis weight areas while the remaining 50% of the web comprises lower basis weight areas.

The ratio between the basis weight of the higher basis weight areas and the basis weight of the lower basis weight areas can also vary. In general, the higher basis weight areas can be from about 1.5 to about 5 times greater than the basis weight of the lower basis weight areas and particularly can be from about 1.5 to about 3 times greater than the lower basis weight areas. For almost all applications, the basis weight of the higher basis weight areas and the lower basis weight areas will fall within the range of from about 0.2 ounces per square yard to about 9 ounces per square yard depending upon the particular application.

The differential basis weight nonwoven webs made according to the present invention can be used either alone or in combination with other materials. For instance, the nonwoven webs can be combined with other webs of material to form a laminate. In one embodiment, for example, the nonwoven web of the present invention produced as described above can be combined with other nonwoven webs, woven fabrics, and/or films, such as polymer films. One particular laminate product that may be

made according to the present invention includes a meltblown nonwoven web positioned between two outer spunbond webs, in which at least one of the outer spunbond webs has a differential basis weight according to the present invention. In this embodiment, the spunbond webs provide durability while the internal meltblown web provides a barrier layer which is porous but which inhibits the strike through of fluids from the inside of the fabric laminate to the outside.

A multi-layer laminate as described above may be formed by a number of different techniques including but not limited to using adhesives, needle punching, ultrasonic bonding, thermal calendering and any other method known in the art. Such laminates are useful for a wide variety of applications. For example, such laminates can be incorporated into wipers, towels, industrial garments, medical garments, medical drapes, medical gowns, foot covers, sterilization wraps, diapers, feminine hygiene products besides various other products.

In one embodiment, a process for producing laminates in accordance with the present invention can include the steps of first constructing a differential basis weight web on a patterned wire and then transferring the unbonded web to a second forming surface to form a second layer on top of the already formed web. This process can be repeated until a desired amount of layers have been brought together. Once the layers have been stacked, the laminate product can then be bonded through, for instance, heat. The different layers contained within the laminate product can each have a differential basis weight in a preselected pattern or, alternatively, some of the layers can have a constant basis weight. Further, in this

embodiment, the layers can all be made from the same process, such as a spunbond process or can be made from different processes including a meltblown process, a bonded carded process, a coform process or an air laid process. According to this embodiment, laminate products can be produced having a particular and desired permeability profile.

Besides nonwoven webs having a differential basis weight, the present invention is also directed to other fabric constructions that have not only good run off properties but good strength properties as well. In order to achieve these objectives, in this embodiment, the present invention is directed to fabric constructions that contain a light weight nonwoven web in combination with a strength enhancing material.

The light weight nonwoven web is provided for giving the fabric integrity, a desired appearance and a desired feel. The light weight nonwoven web can have, for instance, a basis weight of less than about 0.4 OSY (13.6 gsm), and particularly from about 0.1 OSY (3.42 gsm) to about 0.3 OSY (10.2 gsm). At these basis weights, the web has excellent run off properties and will allow a liquid contacting the web to flow therethrough. The nonwoven web can be made according to various processes, such as a meltblown process or a spunbond process.

Although exhibiting good run off properties, a light weight nonwoven web as described above will generally not have good strength characteristics. Consequently, in accordance with the present invention, the light weight nonwoven web is combined with a strength enhancing material which can be, for instance, a polymer screen or, alternatively, a nonwoven web made from

macrofibers. It has been discovered by one of the present inventors that combining a light weight nonwoven web with a screen material or with a nonwoven web made from macrofibers greatly enhances the strength of the light weight web without substantially adversely affecting the run off properties of the web.

The screen material combined with the light weight nonwoven web can be made from, for instance, polymeric filaments, such as nylon monofilaments or polyester monofilaments. The screen material should have a mesh size large enough so as not to inhibit the flow of a liquid through the fabric. For instance, in one embodiment, the screen material can have a mesh size of about 18 x 18 (wires per inch).

In an alternative embodiment, instead of combining the nonwoven web with a screen material, the web can be combined with a second nonwoven web made from macrofibers. It has been discovered that webs made from macrofibers are very strong yet have excellent run off properties. The nonwoven web made from macrofibers can contain staple fibers, meltblown fibers or spunbond fibers. The fibers should have a diameter of at least 20 microns, particularly from about 30 microns to about 80 microns and more particularly from about 40 microns to about 60 microns.

The screen material or the nonwoven web made from the macrofibers can be combined with the light weight nonwoven web according to various methods included but not limited to using adhesives, needle punching, ultrasonic bonding, thermal calendering and any other method known in the art. Such fabric constructions can be used in any of the above described laminates, and are particularly well suited for use as liners in liquid absorbent

products.

The present invention may be better understood with reference to the following examples.

The following tests were performed in order to demonstrate the improved properties of nonwoven webs made in accordance with the present invention.

EXAMPLE 1 (CONTROL)

A light weight spunbond nonwoven web was produced having a basis weight of 0.37 OSY (12.5 gsm).

Run-off tests were performed on three different samples of the spunbond nonwoven web. During these tests, 100 ml of water (at a temperature of about 37°C) was applied to the samples of spunbond web. In particular, the samples were placed on a 30° incline over a liquid absorbent material. During the tests, it was noticed that at the point on each sample where water was hitting the spunbond web, the water began to soak through to the absorbent material and was immediately absorbed. As the water traveled about a 3 inch distance, most of it was absorbed on the way down the liner. In fact, the run-off data for these samples showed that the first and third samples each produced zero run-off while the second sample produced only 1 mL of run-off. Thus, these samples of spunbond nonwoven web produced little to no run-off during experimentation, which is expected from a light weight fabric.

EXAMPLE 2

In this example, tests were performed in order to examine the run-off results when multiple layers of spunbond nonwoven webs are stacked together in comparison to a nonwoven web made in accordance with the present invention.

In the initial test, two layers of the 0.37 OSY spunbond web made in Example 1 were stacked

together, and the amount of run-off observed was 6 mL.

Subsequently, a web was created in accordance with the present invention. In creating the sample, a rectangular sheet of the 0.37 OSY spunbond web was used as the bottom layer. Then, 1 inch wide strips of the 0.37 OSY spunbond web were adhered to the bottom layer using a spray adhesive manufactured by 3M. Two of these strips (stacked one on top of another) were adhered to the bottom layer at approximately 1 inch intervals forming horizontal stripes. Thus, the samples included 1 inch wide strips of only a single layer of spunbond web (0.37 OSY) in between 1 inch wide strips of three layers of spunbond web (1.11 OSY (37.6 gsm)). An example of such a sample is shown in Figure 2 where lower basis weight areas 52 may represent areas of only a single layer of spunbond web and higher basis weight areas 54 may represent areas of three layers of spunbond web. Run-off tests were performed on the sample, and the following data were collected. The sample was arranged so that the strips were positioned perpendicular to the flow of water.

Run #	1	2	3	4	5	6
Run-off (mL)	0.8	1.8	0.5	12	2	21

Run numbers 1-4 involved the fluid impacting the sample at the heavy, three-layer areas of the spunbond web, whereas run numbers 5 and 6 involved impact at the lighter, one-layer areas. In most of the runs, almost all of the fluid was absorbed into the web material. During runs 4 and 6, however, it appeared that the fluid found a low wettability channel and ran off as a result of finding this

channel.

In general, the object of the present invention is to produce a nonwoven web that has the run off properties of a light weight web but the strength of a heavier web. As shown by this example, the sample made in accordance with the present invention had run off properties comparable to a single layer of the spunbond nonwoven web, while having high strength areas that had a basis weight greater than 1 OSY (33.9 gsm).

EXAMPLE 3

In this example, an alternative sample of a nonwoven web was made in accordance with the present invention which included a grid-like pattern of areas of one, two, and three layers of spunbond web. The same spunbond web described in Example 1 was used to make the sample. The sample was made by first laying 1 inch wide strips of the spunbond web over a bottom layer of the web and affixing these strips to the bottom layer using the spray adhesive mentioned above. Subsequently, more 1 inch wide strips of the spunbond web were laid on top of the bottom layer in a perpendicular direction relative to the first layer of strips. Thus, a grid-like pattern of one, two and three layered areas was established.

An example of such a sample is shown in Figure 3 wherein lower basis weight areas 62 may represent areas of only one layer of spunbond web (0.37 OSY), higher basis weight areas 64 may represent areas of two layers of spunbond web (0.74 OSY (25.1 gsm)), and highest basis weight areas 66 may represent areas of three layers of spunbond web (1.11 OSY). As seen in the example shown in Figure 3, fewer areas comprising only one layer of spunbond web were located on this sample than were located on the sample described in Example 2 above.

Run-off tests were performed on the sample, and the following data was collected:

Run #	1	2	3	4
Run-off mL	9.6	3.0	27.0	30.0

It was seen during these runs that when fluid hit an area of two layers of spunbond web, most of the fluid traveled down that double layered area. However, it was seen that if the stream of fluid traveled to an area of only a single layer of spunbond web, the majority of the fluid was absorbed.

EXAMPLE 4

In this example, a further alternative web made in accordance with the present invention was created by cutting holes in one sheet of the 0.37 OSY spunbond web material and affixing this sheet to an uncut sheet of the spunbond web through the use of the above-mentioned spray adhesive. Thus, this sample contained areas of one layer of spunbond web and areas of two layers of spunbond web. An example of such a setup is shown in Figure 4 in which lower basis weight areas 72 may represent the areas on the sample containing only a single layer of spunbond web while higher basis weight areas 74 may represent the areas on the sample containing two layers of spunbond web. It is evident that this sample contained approximately the same amount of single layered areas as did the sample in Example 3. Run-off tests were performed on the sample, and the following data were collected:

Run #	1	2	3	4
Run-off mL	19.0	2.0	30.0	45.0

During the last run in this set, run number 4, the fluid was impacted solely on one of the single layered areas of spunbond web at which time the fluid immediately went through and saturated the absorbent material underneath. Then, the run-off was produced.

Overall, the purpose in testing the different samples containing both multi-layer and single-layer areas of spunbond web material was to determine the effectiveness of incorporating lower basis weight layers of spunbond web material (for softness and low fluid retention) with higher basis weight layers (for strength and durability) according to the present invention. In most cases, these samples demonstrated relatively low amounts of fluid run-off and in turn exhibited the effectiveness of incorporating lower and higher basis weight areas of spunbond material into a web product for use in a diaper liner or the like.

EXAMPLE 5

The following example was performed in order to demonstrate the run off properties of combining a screen material with a nonwoven web. The sample produced is intended to perform similar to a scrim-like material.

In this example, a sheet of the 0.37 OSY spunbond web material described in Example 1 was placed over a nylon screen with an 18 x 18 mesh size. Five run-off tests were performed on five different pieces of spunbond web placed on the nylon screen, and the following results were obtained:

Run #	1	2	3	4	5
Run-off mL	0.0	0.6	0.0	0.2	0.0

As shown above, the sample exhibited excellent run off properties.

EXAMPLE 6

In this example of the present invention, a macrofiber meltblown sheet of nonwoven web material was combined with a light weight spunbond web and tested in run-off experiments.

The meltblown macrofiber nonwoven web had a basis weight of 1.66 OSY (56.3 gsm). The macrofibers incorporated into the web had a diameter of approximately 50 microns. A run-off test was performed on this macrofiber material by itself, and the amount of run-off observed was 2.6 mL.

This same sample of macrofiber was dried and placed under a sheet of the 0.37 OSY spunbond material described in Example 1. Another run-off test was then performed on this double-layered system, and the amount of run-off observed was 2.5 mL.

EXAMPLE 7

The following tests were performed to demonstrate the improved properties of nonwoven webs made in accordance with the present invention.

Spunbond filament webs were produced similar to the process generally described above with reference to Figure 1. In this example, the filaments were made from polypropylene. The filaments used to make the webs had a denier of about 3.8 dpf.

Nonwoven webs were produced having basis weights of 0.3 OSY (10.2 gsm), 0.44 OSY (14.9 gsm), and 0.6 OSY (20.3 gsm). In order to simulate webs

made according to the present invention, rows of tape were placed on samples of the 0.3 OSY basis weight web. By placing tape on the web, those areas on the web became liquid impervious. The tape is intended to represent heavier basis weight areas that are not substantially permeable to liquids. The tape was placed on the web in order to form alternating columns of open areas and closed, liquid impermeable areas.

The liquid run off properties of the webs were tested. The liquid run off test measures a fabric's ability to pass a liquid that comes into contact with the fabric. In general, a run off test includes the steps of placing a sample of the fabric on an angled surface. Specifically, the angle of the surface to the horizontal is 30 degrees. The sample is placed on a retention material that is liquid absorbent. In this example, the retention material included three layers of a coform material. The coform retention material was approximately 8 inches long and had a width of approximately 5.25 inches.

A funnel is placed above the sample so that the bottom of the funnel is 10 millimeters from the top of the specimen. 50 milliliters of a 0.85% saline solution is placed in the funnel which is then poured onto the sample during about a 15 second period of time. The liquid contacts a target zone that is approximately 7 inches from the bottom edge of the retention material. The amount of the saline solution that runs off the fabric is measured. In general, a greater amount of liquid collected reflects a less permeable web. Conversely, little to no run off indicates that the web is highly liquid permeable. In this regard, as used herein, a web configured to pass liquids is defined as a web that will produce less than 5

grams of run off when subjected to the above-described test.

In this example, when the taped webs were placed on the incline surface, the columns were positioned perpendicular to the flow of the solution.

From the above test, the following results were obtained:

Bs. Wt. OSY	Closed Area on Web (in)	Open Area on Web (in)	% Open	Sample	Run-off Water Weight (g)
0.3	1/8	1/8	50.0	1	22.11
0.3	1/8	1/8	50.0	2	16.7
0.3	1/8	1/8	50.0	3	9.93
0.3	1/8	1/8	50.0	4	32.76
0.3	1/8	1/8	50.0	5	4.8
0.3	1/8	1/8	50.0	avg.	17.26
0.3	1/8	1/4	66.7	1	3.83
0.3	1/8	1/4	66.7	2	7.92
0.3	1/8	1/4	66.7	3	4.44
0.3	1/8	1/4	66.7	4	16.04
0.3	1/8	1/4	66.7	5	1.19
0.3	1/8	1/4	66.7	avg.	6.684
0.3	1/8	1/2	80.0	1	3.57
0.3	1/8	1/2	80.0	2	12.31
0.3	1/8	1/2	80.0	3	2.19
0.3	1/8	1/2	80.0	4	1.99
0.3	1/8	1/2	80.0	5	5.02
0.3	1/8	1/2	80.0	avg.	5.016
0.3	none	-	100.0	1	0.54
0.3	none	-	100.0	2	0.18
0.3	none	-	100.0	3	0.91
0.3	none	-	100.0	4	0.79
0.3	none	-	100.0	5	0.84
0.3	none	-	100.0	avg.	0.652
0.44	none	-	100.0	1	27.47
0.44	none	-	100.0	2	4.22
0.44	none	-	100.0	3	28.63
0.44	none	-	100.0	4	25.79

0.44	none	-	100.0	5	10.33
0.44	none	-	100.0	avg.	19.288
0.6	none	-	100.0	1	42.49
0.6	none	-	100.0	2	47.43
0.6	none	-	100.0	3	47.1
0.6	none	-	100.0	4	35.3
0.6	none	-	100.0	5	31.46
0.6	none	-	100.0	avg.	40.756
0.3	1/4	1/4	50.0	1	18.05
0.3	1/4	1/4	50.0	2	9.72
0.3	1/4	1/4	50.0	3	9.31
0.3	1/4	1/4	50.0	4	12.91
0.3	1/4	1/4	50.0	5	13.66
0.3	1/4	1/4	50.0	avg.	12.73
0.3	1/4	1/2	66.7	1	3.81
0.3	1/4	1/2	66.7	2	3.43
0.3	1/4	1/2	66.7	3	8.13
0.3	1/4	1/2	66.7	4	2.21
0.3	1/4	1/2	66.7	5	5.35
0.3	1/4	1/2	66.7	avg.	4.586

As shown above, for conventionally produced webs having a uniform basis weight and containing 3.8 dpf fibers, the amount of run off increases linearly as the basis weight increases. At basis weights greater than about 0.67 OSY (22.7 gsm), practically all of the solution contacting the web should run off the web indicating that the web did not allow any liquid transmission.

With respect to the webs made to simulate webs having a differential basis weight, it was observed that the amount of run off will generally increase as the width of the closed areas is increased and when the width of the open area remains constant.

It is also noticed that larger spacings between the closed areas improved run off results. In general, the run off from the taped webs was controlled by the size of the open areas (which represent light basis weight areas), the actual basis weight of those areas, and the percent of the web that those areas covered.

It can be estimated that the strength (in the direction of the columns) of webs made according to the present invention will be higher than the strength of the light basis weight areas but somewhat lower than the strength of the high basis weight areas. It is believed that the strength of the web can be estimated by multiplying the basis weight of the light basis weight areas times the amount of light basis weight areas which is then added to the result of multiplying the basis weight of the heavier basis weight areas times the amount or percentage of the heavier basis weight areas. For example, for a striped material with ¼ inch strips having a basis weight of 0.3 OSY and ¼ strips having a basis weight of 1.5 OSY (50.9 gsm) , the web should have a strength of

(0.3 OSY) (50% of web) + (1.5 OSY) (50% of web) = 0.9 OSY

Thus, the strength of the above web should be equivalent to a web having a constant basis weight of about 0.9 OSY (30.5 gsm). From the above table, on the other hand, the run off can be estimated to be about 12.7 grams which would be equivalent to a constant basis weight web having a basis weight of 0.39 OSY (13.2 gsm), if it is assumed that run off increases linearly with basis weight.

EXAMPLE 8

Spunbond bicomponent filament webs were produced according to the process generally described above with reference to Figure 1. In

this example, the bicomponent filaments were not crimped. The bicomponent filaments used to make the webs, included a polyethylene component and a polypropylene component in a side by side configuration. The polyethylene used to make the filaments was 6811A linear low density polymer obtained from Dow Chemical and contained 2% by weight TiO_2.

The polypropylene used to make the filaments, on the other hand, was ESCORENE 3445 obtained from the Exxon Corporation and contained 2% by weight TiO_2.

The polypropylene component and the polyethylene component were fed into separate extruders. The extruded polymers were spun into round bicomponent filaments using a spinning die. From the spinning die, the filaments were fed through a fiber draw unit.

The drawn filaments were deposited onto a foraminous surface to form a nonwoven web which was passed through a point bonder. In this Example, the denier of the filaments was about 2 dpf. The foraminous surface used in this example was TRIFORM C2 wire obtained from Albany International of Portland, Tennessee. The forming wire had the following characteristics:

Mesh: 80 x 80
Warp: 0.35mm Polyester
Shute:
  Forming Side: 0.35mm Poly
  Forming Side: 0.25mm Cond
  Middle: 0.35mm Poly
  Wear Side: 0.40mm Poly
Nominal Caliper: 0.072"
Nominal Air Perm: 770 cfm
Weave: Triple Stacked Shute

Nine different nonwoven webs were produced and

tested. Seven of the nine webs were produced according to the present invention and contained alternating columns of higher basis weight areas and lower basis weight areas extending in the machine direction. The low basis weight areas were formed by completely blocking off columnar sections of the forming wire using an adhesive. Specifically, the following webs were formed:

Sample No.	Open Area On Forming Wire (Inches)	Closed Area On Forming Wire (Inches)	Basis Weight (OSY)
1	1/8	1/8	0.8
2	1/8	1/8	0.5
3	1/8	1/8	0.4
4	1/8	1/8	0.3
5	1/8	1/8	0.2
6	3/8	1/8	0.5
7	3/8	1/8	0.3
8	Control 100% open		0.5
9	Control 100% open		0.2

The control samples listed above, samples 8 and 9, were made according to conventional methods. As shown above, for samples made according to the same pattern, the basis weight was varied. The basis weight listed above for the samples made according to the present invention refers to the average basis weight of the web across the entire width. In general, for samples 1 through 7, the basis weight of the higher basis weight areas was 1.7 times greater than the basis weight of the lower basis weight areas, which were formed by blocking off the wire.

Each of the samples listed above were tested for peak load and peak energy in the cross machine direction and in the machine direction. The liquid run off properties of the webs were also tested.

Peak load and peak energy measurements of the samples were obtained by conducting a tensile test on the samples. A tensile test is a measure of breaking strength of a fabric when subjected to unidirectional stress. Higher numbers indicate a stronger fabric. The term "load" means the maximum load or force, expressed in units of weight, required to break or rupture the specimen in a tensile test. The term "peak energy" means the total energy under a load versus elongation curve exerted prior to rupture or break.

The liquid run off test used was the same as described in Example 7.

From the above tests, the following results were obtained:

SAMPLE	CD (lbs) Peak Load	CD (lbs) Peak Energy	MD (lbs) Peak Load	MD (lbs) Peak Energy	Runoff (gm)	Basis Weight
1	2.87	5.34	4.48	7.13	46.98	0.8
2	1.55	2.80	2.54	2.54	44.54	0.5
3	1.15	1.71	2.02	3.02	26.40	0.4
4	0.83	1.30	1.37	1.78	16.32	0.3
5	0.44	0.70	0.79	0.86	1.90	0.2
6	1.63	2.37	2.32	3.10	35.63	0.5
7	0.84	1.10	1.30	1.79	12.25	0.3
8	1.33	2.79	3.07	5.0	43.71	0.5
9	0.30	0.49	0.91	1.1	1.65	0.2

With respect to the run off properties of the webs tested made according to the present invention

in comparision to the controls (Samples Nos. 8 and 9), some improvements were observed in some of the tests, but generally the run off properties between the control samples and the webs made according to the present invention were similar. Although these results are still favorable, it is believed that significant improvements in run off properties were not shown because the webs were made from small denier filaments, having a denier of about 2 dpf. At smaller deniers, the filaments create less void space in the web and are not as effective in passing liquids.

In order to compare the strength data, the following table is provided in order to better compare some of the above information.

Sample No.	Basis Weight (OSY)	Open Area On Forming Wire (Inches)	Closed Area On Forming Wire (Inches)	CD (lbs) Peak Load	MD (lbs) Peak Load
2	0.5	1/8	1/8	1.55	2.54
6	0.5	3/8	1/8	1.63	2.32
8	0.5	open	-	1.33	3.07
5	0.2	1/8	1/8	0.44	0.79
9	0.2	open	-	0.30	0.91

As shown above, when comparing webs made according to the present invention in relation to the control samples, it is observed that although the machine direction tensile strength is somewhat decreased, the cross direction strength is improved. This was very unexpected because the sample was being tested in the direction of alternating light and heavy areas and it was expected that the web would tear at and have the

properties of the light areas. It is believed that webs made according to the present invention have more fiber orientation in the cross machine direction than conventionally made webs. Consequently, the cross direction strength is increased. Ultimately, webs made according to the present invention have better overall strength properties in that the strength in the machine direction is more equal to the strength in the cross machine direction. In other words, webs made according to the present invention have a tendency to have a more uniform strength over the entire area of the web.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims.